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Fingerprints in online media reveal the organization of social systems

Renaud Lambiotte

The Internet's technological revolution spreads into the social sciences as networking sites and the virtual worlds of web-based games facilitate studies of unprecedented scale.

Quantitative analysis in the social sciences has historically relied on small-scale and static data, typically gathered by questionnaires or observing people in their daily lives. The last few years have witnessed a change of paradigm driven by the emergence of pervasive technologies that fill electronic databases with information about our everyday lives. This may be our personal relations, our whereabouts, or even our taste in music or literature.[1] Through this window of data, researchers observe the collective behaviour of millions of individuals and search for common trends and underlying patterns.[2–6] In parallel, the advent of Internet gaming provides a huge pool of potential participants in online studies, making it possible to conduct laboratory-style experiments involving thousands of people.[7,8] These studies offer exciting research perspectives by providing the first empirical observations of the dynamics and organization of social systems at a large scale, with the potential to radically improve our understanding of human societies.

The sheer size and sensitive nature of the data raises a series of theoretical, algorithmic and ethical issues. First, traditional social graph theory, which was originally developed to analyse how the connections in small and static networks affect how they function, needs a thorough update to deal with dynamical networks made of millions of nodes. For instance, the algorithms that provide readable maps of the system organization must be more efficient.[9,10] Another crucial challenge is the development of robust data-sharing practices to facilitate research and respect user privacy. Finally, the field of online experimentation, which is still in its infancy, requires the adoption of common protocols. An example would be setting up incentives, such as services or micropayments, for participation in crowd-sourcing platforms.

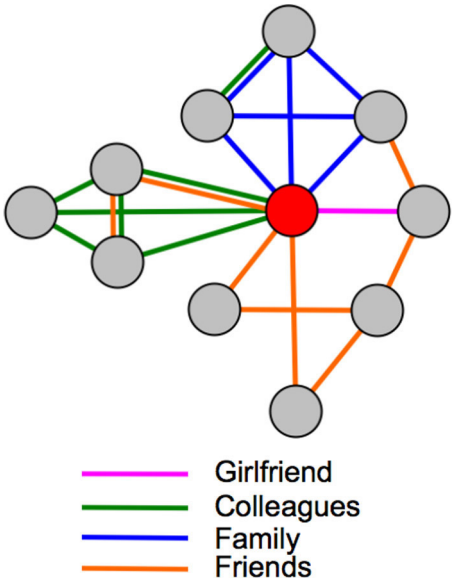

Figure 1. *The ego-network around the red individual is composed of connections that correspond to different social processes. Most studies of large-scale networks tend to overlook this aspect, simply identifying the presence or absence of relations. Such representation leads to a limited and sometimes misleading characterization of the social network as a whole.*

Large-scale studies often rely on coarse descriptions of the individuals and their relations. For instance, in the tradition of statistical physics, the internal state of an individual is often modeled as a binary variable, for example 'sell' or 'buy,' thereby over-simplifying its complex nature. Similarly, the type of relation between individuals is usually neglected, and is either approximated by a binary variable, such as 'present' or 'absent,' or by a weight characterizing its intensity. Attempts to improve the measurement of such details include real-world experiments where people wear 'sociometers'[12] that capture physical proximity, location, movement and other facets of their social life.

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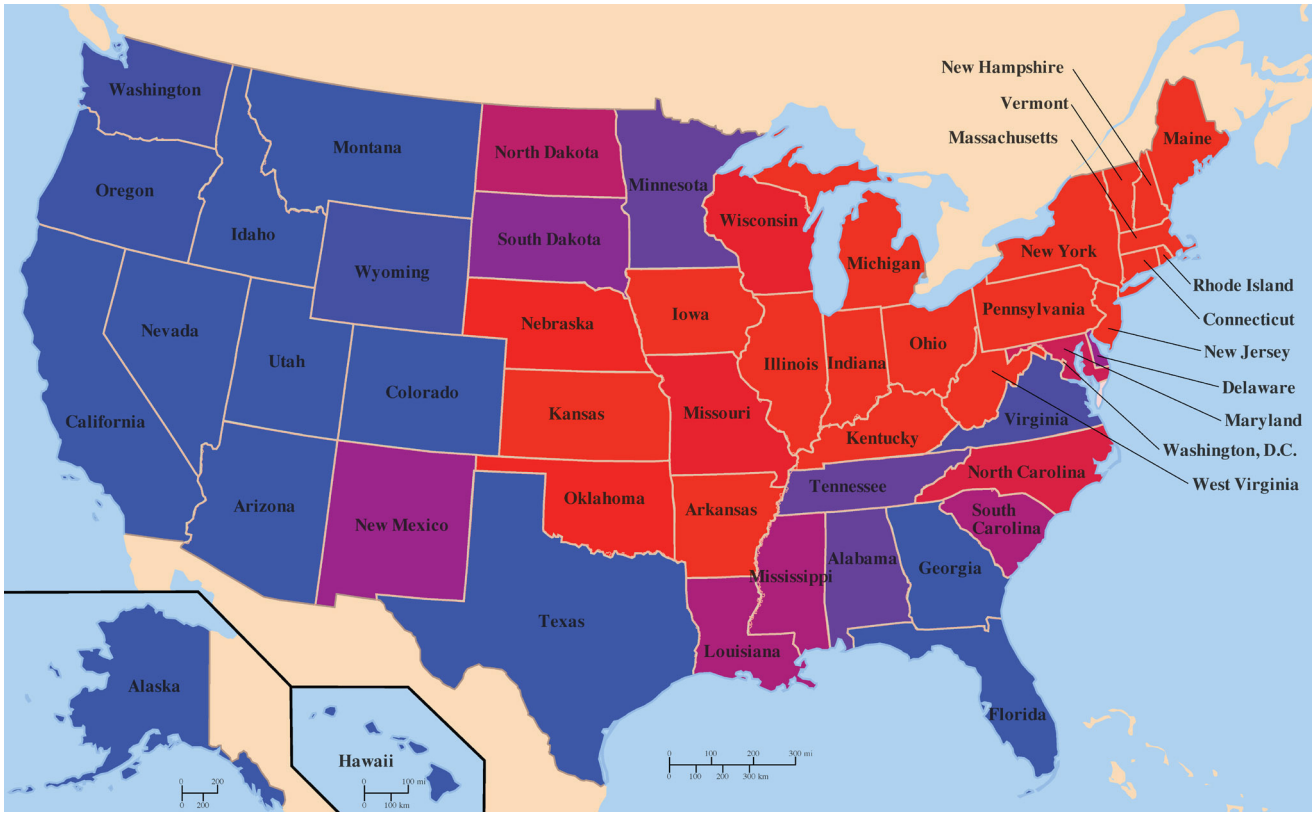

Figure 2. *Statewide variations in neuroticism, a personality trait associated with emotional impulsiveness, as calculated from MyPersonality[11] data. Red corresponds to states whose values are statistically over the average, while blue states are below average.*

However, those experiments tend to be limited in size. Our work aims at uncovering the nature of social relations between individuals and at providing a detailed measure of their internal state at a large scale.

A set of nodes connected by different types of relations is called a multiplex or multi-relational network[13] (see Figure 1). In order to measure multiplexity in large social systems, we turned to the *Pardus* massive multiplayer online game.[14] In such a game, players are immersed in a virtual world where they experience an alternative life with a variety of possible social interactions among players. Virtual worlds offer a series of advantages for research: for instance, all information about actions taken by players is stored in log files, and experiments that would have been otherwise unacceptable or impossible can be conducted.[15] In our work,[16] we extracted networks based on six different types of one-to-one interactions between the players. We observed significant topological differences between networks with a positive connotation (friendship, communication or trade) and those with a negative connotation (enmity, armed aggression or punishment). We also studied the interdependence of different network types and presented the first empirical large-scale verification of structural balance theory.[16, 17] This theory predicts that certain types of network motifs are stable, and thus over-represented, in networks with conflictual relations.

Another important aspect missing from previous works is a characterization of the internal state of individuals. A psychological profile is a good candidate for capturing this state. To explore that idea, we analysed data from the highly popular *MyPersonality* Facebook application,[11] which has surveyed millions of Facebook users with peer-reviewed personality tests. Coupled with standard Facebook information about the users, this data allowed us to address a range of hitherto unanswered questions, such as whether personality affects social behaviour, correlates with taste in movies[18] or shows significant geographical variations[19] (see Figure 2). In particular, we performed a

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study of the relationship between sociometric popularity (number of Facebook contacts) and personality traits using data from 200,000 individuals,[20] the first of its kind on a large number of subjects. We found that the strongest predictor for an individual's number of contacts is a trait called extraversion, which is usually associated with sociability and excitement-seeking, while other personality traits do not play a significant role.

Social science is about studying how behaviour on a societal level emerges from a large number of interactions between individuals. However, those interactions and the intrinsic properties of individuals are hard to measure, especially at a large scale. Our work aims to find the right balance between high-quality data in small systems and low-quality data in large systems. To do so, we have focused on new types of data in virtual worlds and in Facebook. This approach has opened new research directions related to the dynamics and organization of conflict and to the effect of personality on social behaviour. As a next step, we will explore in detail the dynamic nature of social networks, namely the rearrangement of links in time, and develop theoretical models and algorithms to help understand the temporal behaviour of social networks.

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References

1. D. Lazer, A. Pentland, L. Adamic, S. Aral, A.-L. Barabási, D. Brewer, N. Christakis, *et al.*, *Computational social sciences*, **Science 323**, pp. 721–724, 2009.
2. L. Adamic and N. Glance, *The political blogosphere and the 2004 US election: divided*, **Proc. 3rd Int'l Workshop Link Discovery**, pp. 36–43, 2005. doi:10.1145/1134271.1134277
3. J. Leskovec, L. Adamic, and B. Huberman, *The dynamics of viral marketing*, **ACM Trans. Web 1**, p. 1, 2007.
4. J.-P. Onnela, J. Saramäki, J. Hyvönen, G. Szabó, D. Lazer, K. Kaski, J. Kertész, and A.-L. Barabási, *Structure and tie strengths in mobile communication networks*, **Proc. Nat'l Acad. Sci. USA 104**, pp. 7332–7336, 2007.
5. R. Lambiotte, V. D. Blondel, C. de Kerchove, E. Huens, C. Prieur, Z. Smoreda, and P. Van Dooren, *Geographical dispersal of mobile communication networks*, **Physica A 387**, pp. 5317–5325, 2008.
6. M.C. González, C.A. Hidalgo, and A.-L. Barabási, *Understanding individual human mobility patterns*, **Nature 453**, pp. 479–482, 2008.
7. D. J. Watts, *A twenty-first century science*, **Nature 445**, p. 489, 2007.
8. M. J. Salganik and D. J. Watts, *Web-based experiments for the study of collective social dynamics in cultural markets*, **Topics Cognit. Sci. 1**, pp. 439–468, 2009.
9. M. Rosvall and C.T. Bergstrom, *Maps of random walks on complex networks reveal community structure*, **Proc. Nat'l Acad. Sci. USA 105**, pp. 1118–1123, 2008.
10. V. D. Blondel, J.-L. Guillaume, R. Lambiotte, and E. Lefebvre, *Fast unfolding of communities in large networks*, **J. Stat. Mech.**, p. P10008, 2008.
11. Homepage of the *MyPersonality* research project. http://www.mypersonality.org/
12. A. Pentland, **Honest Signals: How They Shape Our World**, MIT Press, 2008.
13. M. McPherson, L. Smith-Lovin, and J.M. Cook, *Birds of a feather: homophily in social networks*, **Annu. Rev. Sociol. 27**, pp. 415–444, 2001.
14. Homepage of the *Pardus* massive multiplayer online browser game. http://www.pardus.at
15. W. S. Bainbridge, *The scientific research potential of virtual worlds*, **Science 317**, pp. 472–476, 2007.
16. M. Szell, R. Lambiotte, and S. Thurner, *Multi-relational organization of large-scale social networks in an online world*, **Proc. Nat'l Acad. Sci. USA 107**, pp. 13636–13641, 2010.
17. J. Leskovec, D. Huttenlocher, and J. Kleinberg, *Predicting positive and negative links in online social networks*, **Proc. Int'l Conf. World Wide Web**, pp. 641–650, 2010.
18. O. Chausson, *Who watches what?: assessing the impact of gender and personality on film preferences*. Paper published online on the *MyPersonality* project website. http://mypersonality.org/wiki/doku.php?id=movie_tastes_and_personality
19. P. J. Rentfrow, *Statewide differences in personality: toward a psychological geography of the United States*, **Amer. Psych. 65**, pp. 548–558, 2010.
20. D. Quercia, R. Lambiotte, M. Kosinski, D. Stillwell, and J. Crowcroft, *The personality of popular Facebook users*, **Proc. ACM Conf. Comput. Support. Cooperat. Work**, 2012. To appear.